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$$\therefore \left(\frac{dx}{dt}\right)^2=(g/a)(2ax-x^2+b^2-2ab)=v^2.$$

When $x=0$, $v=\sqrt{\frac{gb}{a}(b-2a)}$ = velocity of projection, h = height of projection $=\frac{v^2}{2g}=\frac{b}{2a}(b-2a)$, but $h=2l$ and $a=l$.

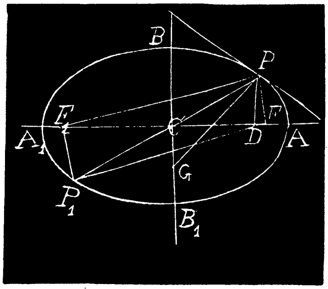
$$\therefore\ 2l=(b/2l)(b-2l) \text{ or } b=l(1+\sqrt{5}).$$

62. **Proposed by J. SCHEFFER, A. M., Hagerstown, Md.**

A particle of mass m moves in the circumference of an ellipse with constant rate v. It is constrained to move in that circumference by attractive forces in the two foci. To determine the magnitude of these forces,

I. **Solution by G. B. M. ZERR, A. M., Ph. D., President and Professor of Mathematics, The Russell College, Lebanon, Va.**

Let P be the particle mass m, $CA=a$, $CB=b$, $PF=r$, $PF_1=r_1$, $CD=x$, $PD=y$, force along $r=f$, force along $r_1=f_1$. R= normal reaction, X=component of f and f_1 parallel to AC, Y=component of f and f_1 parallel to CB, $x^2/a^2+y^2/b^2=1$, the equation to the ellipse. The equations of motion are



$$m(d^2x/dt^2)=X-R(dy/ds)\,;\ m(d^2y/dt^2)=Y+R(dx/ds)\ldots\ldots(1,2).$$

Now $ds/dt=v$, $\frac{dx}{ds}=\frac{a^2y}{\sqrt{a^4y^2+b^4x^2}}=\frac{ay}{b\sqrt{rr_1}}$, $\frac{dy}{ds}=\frac{b^2x}{\sqrt{a^4y^2+b^4x^2}}=\frac{bx}{a\sqrt{rr_1}}$

$$\left(\frac{dx}{dt}\right)^2=\left(\frac{ds}{dt}\right)^2\frac{a^4y^2}{a^4y^2+b^4x^2}=\frac{a^2v^2y^2}{b^2(a^2-e^2x^2)}=\frac{v^2(a^2-x^2)}{a^2-e^2x^2}.$$

$$\left(\frac{dy}{dt}\right)^2=\left(\frac{ds}{dt}\right)^2\cdot\frac{b^4x^2}{a^4y^2+b^4x^2}=\frac{b^2v^2x^2}{a^2(a^2-e^2x^2)}.$$

$$\therefore\ \frac{d^2x}{dt^2}=-\frac{a^2v^2x(1-e^2)}{(a^2-e^2x^2)^2}=-\frac{b^2v^2x}{r^2r_1^2},\ \frac{d^2y}{dt^2}=\frac{a^2v^2y}{(a^2-e^2x^2)^2}=\frac{a^2v^2y}{r^2r_1^2}.$$

$$R=(f+f_1)\cos FPG=b^2(f+f_1)/\sqrt{(b^4+a^2e^2y^2)}=(f+f_1)/\sqrt{(rr_1)}.$$

$$X=f_1\cos EPF_1+f\cos EPF=f_1(ae+x)/r_1-f(ae-x)/r.$$

$$Y=f_1\cos DPF_1+f\cos DPF=y(f_1r+fr_1)/rr_1.$$

Substituting in (1) and (2),

$$-ab^2mv^2x=rr_1(arx+a^2er-bx)f_1+rr_1(ar_1x-a^2er_1-bx)f\ \ldots\ldots\ldots\ldots\ldots\ (3).$$

$$a^2bmv^2=rr_1(br+a)f_1+rr_1(br_1+a)f \ldots\ldots\ldots\ldots (4).$$

From (3) and (4) since $x=(r_1-r)/2e$,

$$\frac{f_1r}{a^2r-b^2r_1}=\frac{fr_1}{a^2r_1-b^2r}=\frac{abmv^2}{2[(a^2+b^2+a^2be^2)rr_1-2a^2b^2]}.$$

II. Solution by **WILLIAM HOOVER, A. M., Ph. D.**, Professor of Mathematics and Astronomy, Ohio University, Athens, Ohio.

Let ρ=the radius of curvature of the curve at any position, P, of the particle, ϕ=the angle included by either SP or HP, S and H being the foci, and $2a$ =the major axis. Let CD be the semi-diameter conjugate to CP, C being the center of ellipse.

The normal components of the central attractions must together equal the centrifugal force. We may assume the forces in S and H as proportional to some power of CD; and if the absolute intensities of the two forces are equal, say μ,

$$[\mu(CD)^n+\mu(CD)^n]\cos\phi=v^2/\rho \ldots\ldots\ldots\ldots (1).$$

But $\rho\cos\phi=\dfrac{SP.HP}{a}=\dfrac{CD^2}{a} \ldots\ldots\ldots\ldots (2)$,

and (1) is $2\mu(CD)^n.\dfrac{CD^2}{a}=v^2 \ldots\ldots\ldots\ldots (3)$.

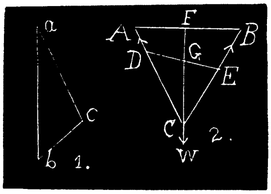
For v=a constant, requires that $n=-2$, showing plainly that the forces vary inversely as the product of the focal distances of the particle.

63. Proposed by A. H. BELL, HILLSBORO, Ill.

From a horizontal support at a distance of ten feet apart, a beam 5 feet long and 10 pounds weight is suspended by ropes attached to each end. The ropes are 3 and 5 feet respectively, in length. Required the angles made by the ropes and horizontal support. Also the stress upon each rope.

Solution by **G. B. M. ZERR, A. M., Ph. D.**, President and Professor of Mathematics, The Russell College, Lebanon, Va.

Regarding the bar DE as uniform so that the middle point is the center of gravity, we must have, for equilibrium, the three forces AD, BE, GC passing through the same point C, with GC perpendicular to AB.



The $\angle ABC=\angle CDE$, and the $\angle BAC=\angle CED$.

Let $\angle ABC=\theta$, $\angle BAC=\varphi$, stress on $BE=R$, on $AD=R_1$, weight of $DE=W=10$ pounds. Also $AB=10$, $BE=ED=5$, $AD=3$, $AE^2=100+25-100\cos\theta=25+9+30\cos CDE$.

$\therefore$ $130\cos\theta=91$. $\therefore$ $\cos\theta=\frac{91}{130}=.70000$. $\therefore$ $\theta=45^\circ\ 34'\ 23''$.
$DB^2=100+9-60\cos\varphi=25+25+50\cos CED$.
$\therefore$ $110\cos\varphi=59$. $\therefore$ $\cos\varphi=\frac{59}{110}=.53636$. $\therefore$ $\varphi=57^\circ\ 33'\ 50''$.